Space Weather Technical Forecast

Issued on Thursday, 06 October 2022 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Potential CME arrival late day 1 or early day 2 (6th or 7th), with a chance of G1 Minor - G2 Moderate storms. Chance of isolated M-flares with a slight chance X-flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with only C-class background flares in the last 24 hours. There are currently a total of five numbered sunspot regions. AR3112 Fki/Beta-gamma-delta is a large a complex region, although has remained relatively stable despite the presence of a compact intermediate region with a couple of delta spots visible. The other main recent activity was from AR3110, which along with AR3113, have now rotated away over the western solar horizon. AR3116 Eai/Beta, to the north of AR3112, is the other region of interest with some small spot proliferation both in its intermediate region and also ahead of its leader. The remaining regions are all relatively simple and inactive, while a couple of new small flux emergences have been observed in the northeast disc. No Earth-directed CMEs have been observed in the last 24 hours, although the solar disc has a number of filaments which would have the potential to produced Earth-directed CMEs if they lift.

Solar Wind / Geomagnetic Activity: Solar winds observed by DSCOVR at L1 perhaps showed the peripheral influence of a CME. Speeds have persisted at slightly elevated to elevated levels, between 450-530 km/s, however an increase in density was observed at around 05/1610UTC, from below average to just above average levels. This then eased again, before any increase to just above average was observed at 06/0300 UTC. The total IMF strength (Bt), increased in response to this first density jump, from weak levels below 6nT to be weak to moderate at 5-9nT. The north-south component Bt, remained weakly varying between -7 and +7nT, but perhaps more frequently in a negative (southward) direction. The phi angle was predominately positive (away from the Sun). Resultant geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at background levels. High energy electron flux (greater than 2 MeV) increased from moderate to high levels, peaking at 2.63e3 pfu, before returning to moderate levels. Electron fluence remained below the Active threshold, with a steady trend since 06/0000UTC. The observed fluence at 06/0000 UTC was 5.06e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with the activity risk predominately from the large northern sunspot AR3112. There is a slight chance of this increasing to High.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on the 4th, due to a filament eruption in the southern central disc has the potential to arrive at Earth late day 1 or early day 2 (6-7th), although confidence is Low. This may lead to slightly elevated to elevated winds persisting through day 2 (7th). Otherwise current fast winds are expected to gradually fade, before the next fast wind enhancement either later day 3 or day 4 (8th or 9th) from CH29. Geomagnetic activity is forecast to be Quiet to Active at first, but with a chance of increasing to

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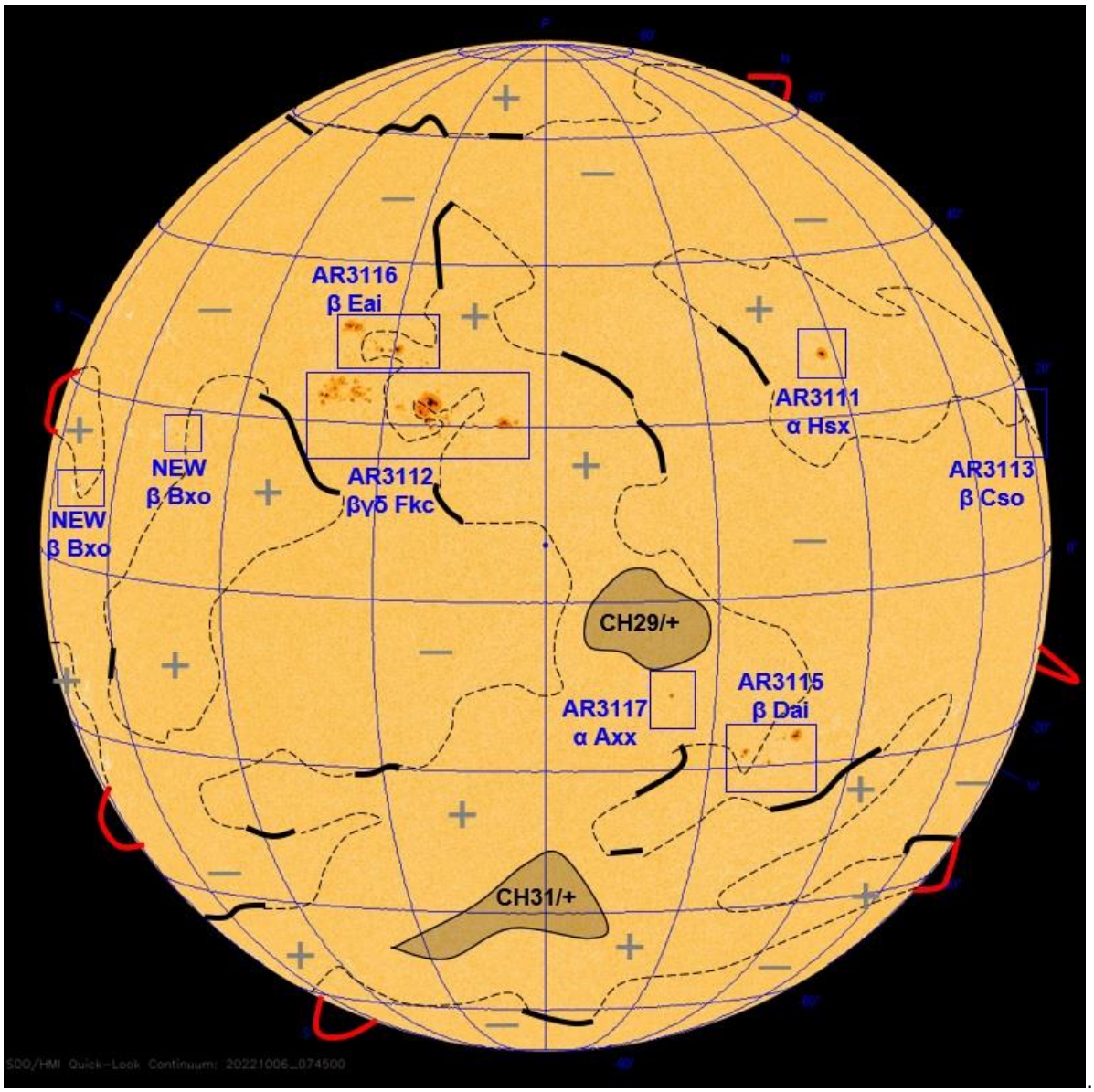
G1/Minor to G2/Moderate storm from any CME arrival. Activity then easing to Quiet to Unsettled for a time by day 3 (8th), but with a chance of Active intervals and a slight chance of G1/Minor Storms from any fast wind arrival from CH29 later in the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a slight risk of minor proton storms, most likely due to AR3112. Electron flux is likely to recover from recent CME sourced suppression, with an increasing chance of reaching High through the period. However, the further CME arrival possible ate day 1 or 2 gives low confidence for this recovery. This will bring a chance of associated 24 hour electron fluence reaching Active day 3 (8th)

Figure 1. Solar Analysis Valid 06/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption around 04/1300 UTC resulted in a CME which has been analysed as passing mostly to the south of Earth late on day 1 (6th), but with a chance of arriving at Earth around 06/2100 UTC +/- 12 hours. This has lower than usual confidence due to only limited SOHO Lasco coronagraph imagery being available for analysis.

Solar winds at Earth were likely recently enhanced by another weak CME arrival, perhaps due to the large SE quadrant filament eruption on the 3rd. This only brought peripheral influences but has maintained slightly elevated to elevated solar winds through day 1 (6th), at around 500km/s. In the absence of any further CME interaction, these would be expected to gradually ease through the period, however the expected arrival later on day 1 is likely to result in elevated winds persisting, before gradually easing later day 2 (7th). Central disc CH29 is a new feature on this rotation, however a further slight enhancement is possible later day 3 (8th) or during day 4 (9th) as Earth encounters its fast wind. This low confidence however, due to a lack of persistence, and also no notable signal from this feature in current enlil model winds.

Geomagnetic activity is forecast to be Quiet to Active at first, but with a chance of increasing to G1-G2 Minor to Moderate storm from any CME arrival late day 1 and through day 2 (6th and 7th). Activity then easing to Quiet to Unsettled for a time day 3 (8th), but with a chance of Active intervals and a slight chance of G1/Minor Storms from any fast wind arrival from CH29 later day 3 or day 4 (8th or 9th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	40	10	20
Strong	G3	No	2	2	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1734	Partial	Filament	SW	980 km/s	06/2100	Low confidence with limited LASCO imagery. Passes to south.

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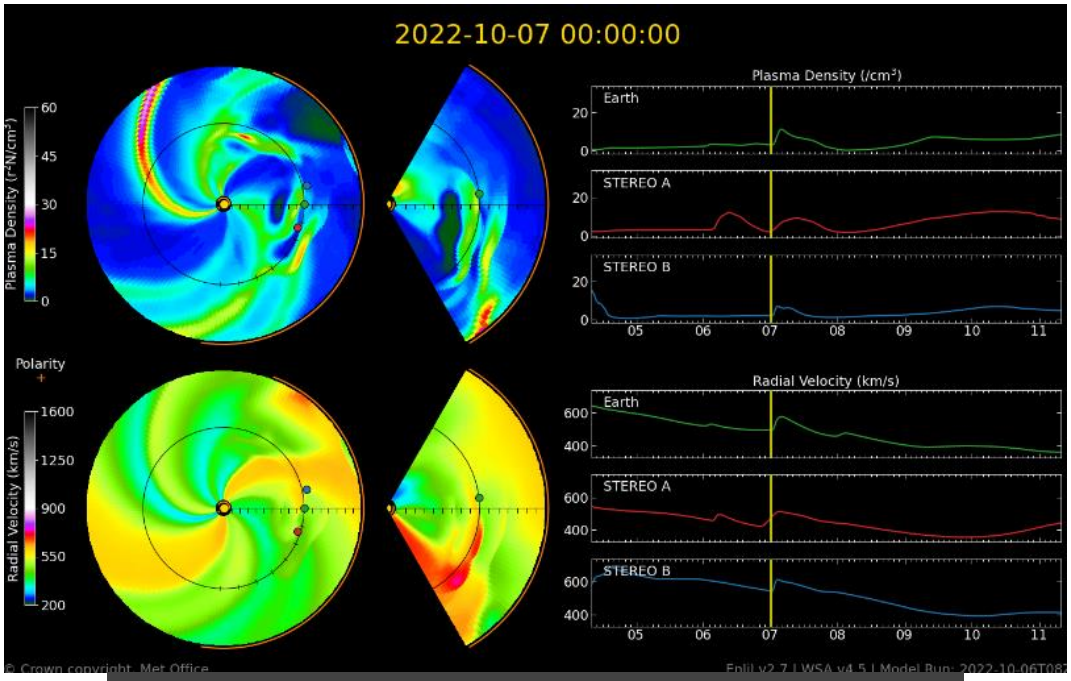
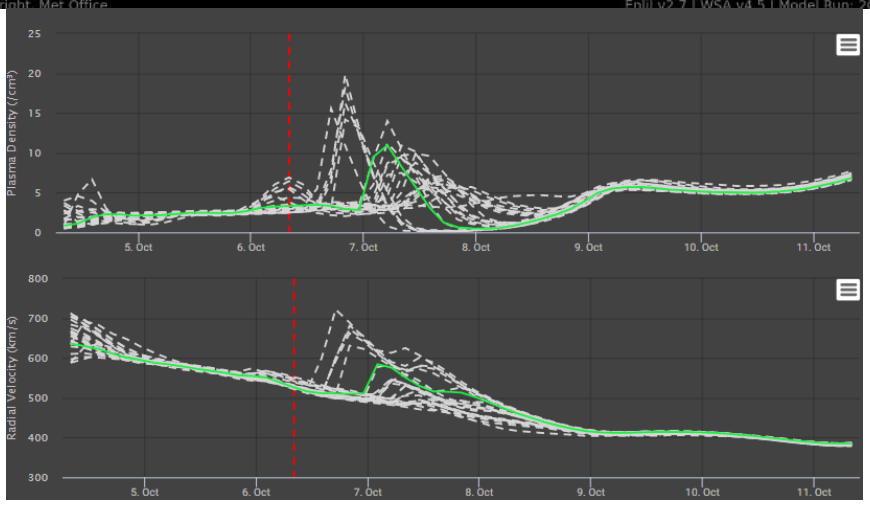
Figure 2: Most recent enlil showing potential CME arrival, slightly after current forecast, with ensemble showing wide spread of potential impacts.





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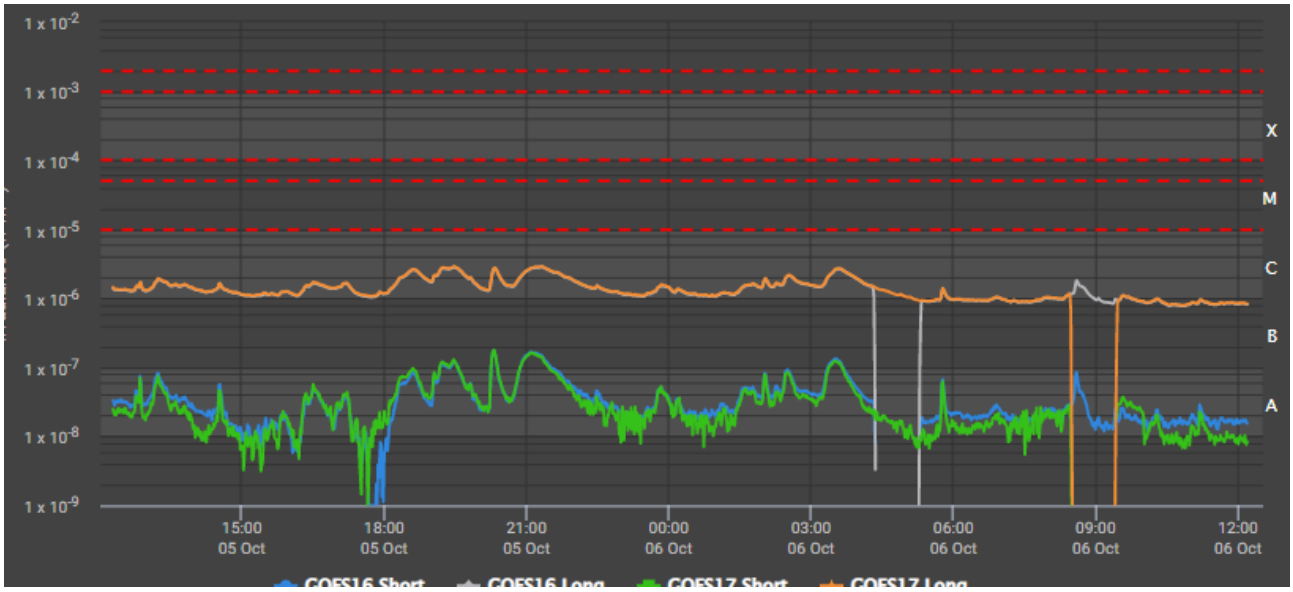
Radio Blackouts - X-Ray Flares:

Solar activity is at Low levels with only background C-class activity on the last 24 hours. Low to Moderate activity is expected to continue. There are five numbered regions now visible on the disc, along with a few new but small flux emergences in the northeast quadrant

AR3112 Fki/Beta-gamma-delta just east of centre disc is the main region of interest. This has an atypical structure, as a longitudinally spread region composed of a number of smaller and weaker spots, but with a notable and larger compact intermediate region comprising of a couple of delta spots. Due to this structure, the classification has recently been simplified slightly, and this is supported by its apparent stability with only limited recent flaring observed. Of the other regions on the disc, AR3116 Eai/Beta, to the north of AR3112, is the most likely source of any notable activity, having exhibited some limited growth.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	20	20	15	15

Figure 3: GOES 16-17 X-ray Flux



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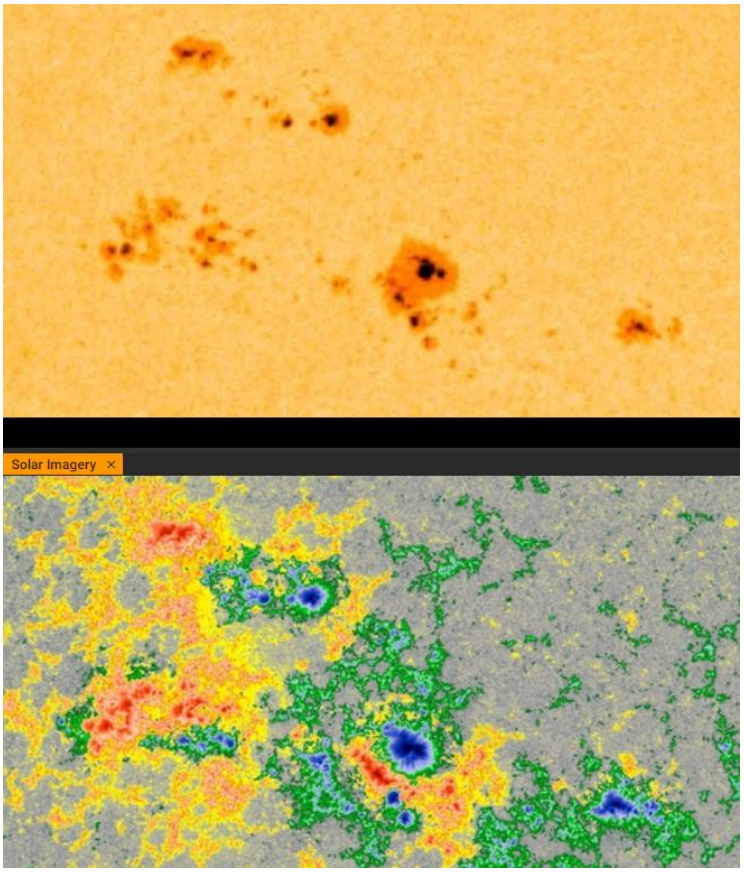
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is at background levels. There is a slight chance of exceeding the S1 threshold, primarily from AR3112 near centre disc given any sufficiently strong flare event, but also from just over the limb due to any further M or X-flares from ex-AR3110 which has now rotated off the Earth-side disc

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO Intensitygram and Magnetogram of AR3112 and AR3116



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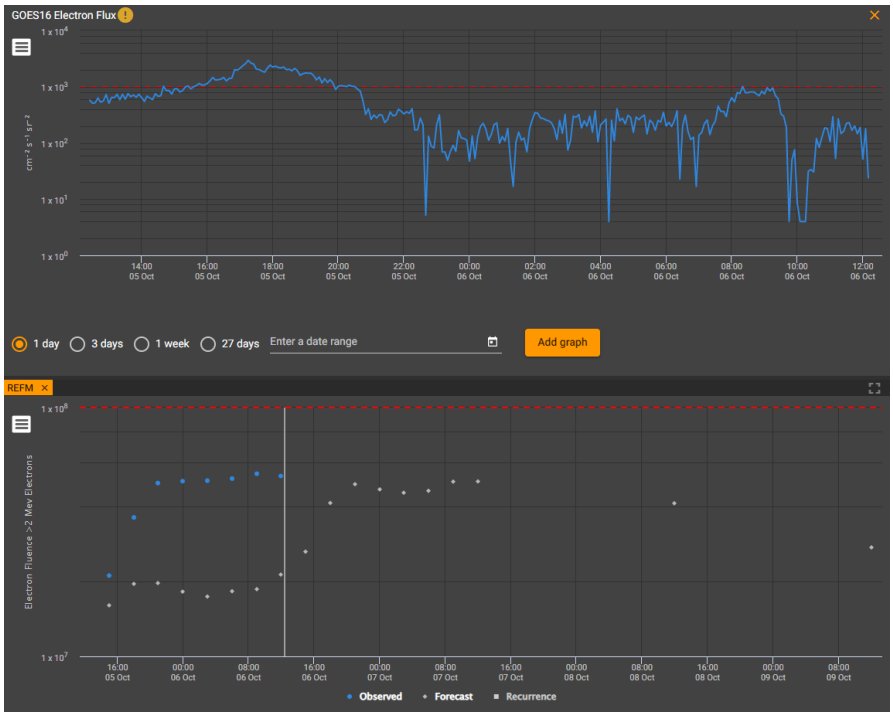
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV), as measured by GOES-16 has recently been suppressed due to the glancing CME influences observed late on the 5th and early 6th. A further CME arrival later day 1 (6th) has the potential to further suppress these observed values until any CME influence eases later day 2. As solar winds ease, especially into day 3 and 4 (8th and 9th), there is an increasing chance of high flux levels being observed, although this could again become suppressed from any fast wind arrival from CH29 late day 3 or 4.

The associated 24 hour electron fluence is expected remain below the Active threshold day 1 (6th). Any rise above Active day 2 (7th) will be dependent upon the extent of any CME impact. However flux is likely to rise sufficiently by day 3 to give a period of Active Fluence before the arrival of the fast wind of CH29 suppresses observed flux levels again later in the period. REFM is likely giving poor guidance at the moment, due to its inability to account for the recent peripheral CME influence, along with the potential CME arrival later day 1.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	60	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5:GOES-16 >2MeV Electron Flux and Fluence with REFM



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